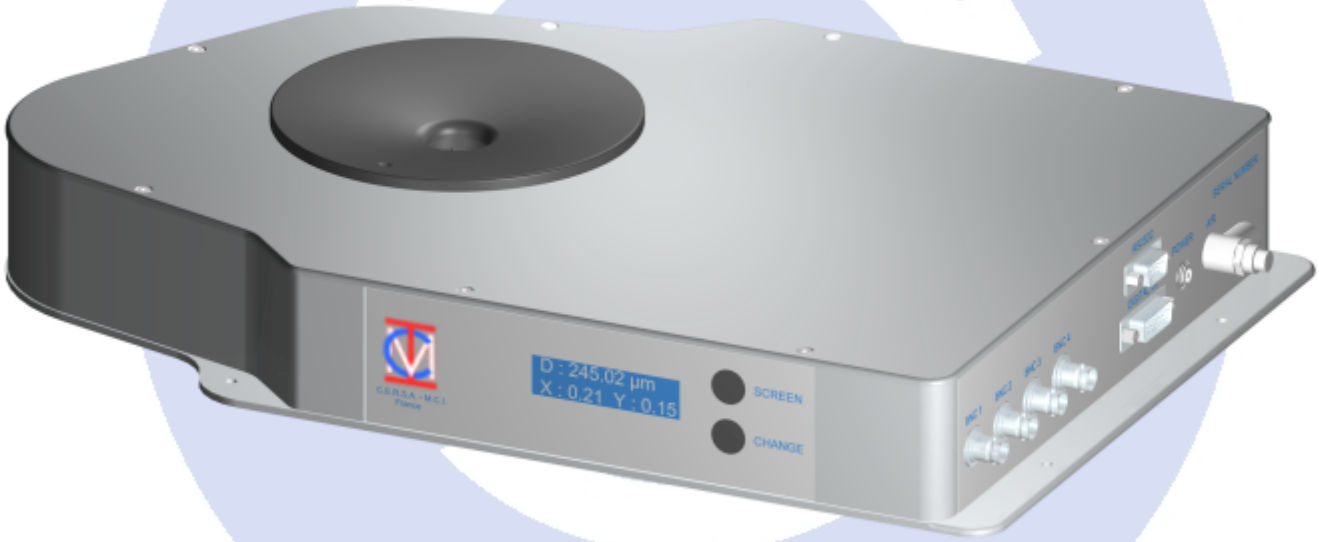
Measure & Control Instruments

# LDS0400-T
# Laser Diffraction Sensor for Transparent product
# User's manual.

Manual version : 11.0.0

© 2012 CERSA-MCI




**CERSA-MCI**

53, parc Expobat
13480 CABRIES
FRANCE

tel: +33 (0)4 42 02 60 44
fax: +33 (0)4 42 02 79 79

**web: http://www.cersa-mci.com**
**email: sale@cersa-mci.com, support@cersa-mci.com**

Conception Etude Réalisation
Electronique-Informatique
Mesures-capteurs
Energie-mécanique
Systèmes Automatisés
CERSA

# Table of Contents


Part I Introduction 4

Part II Specifications 5

1 General specifications ..... 5
2 Mechanical design ..... 6

Part III CIM software 8

Part IV Measures and principle 9

1 Generalities ..... 9
1.1 Available measures ..... 9
1.2 Events ..... 9
1.3 Real time scopes ..... 10
2 Diameter ..... 10
2.1 Optical principle ..... 10
2.2 Diffraction scope ..... 11
2.3 Real time diameter scope ..... 11
3 Position and vibration ..... 11
3.1 Principle ..... 11
3.2 Vibration scope ..... 12

Part V Connexions and Interfaces 13

1 Digital I/O ..... 13
2 Length counting use ..... 15
3 Serial link ..... 16
4 BNC Outputs ..... 17
5 Front panel ..... 17
6 External power supply ..... 19
7 Air supply ..... 19

Part VI Instrument settings 20

1 Tolerances ..... 20
2 Measure parameters ..... 20

Part VII Installation on the line 22

1 Mounting ..... 22
2 Alignment ..... 22

Part VIII Maintenance, security and troubleshooting 23

1 Safety rules ..... 23
2 Optical system cleaning ..... 23
3 Error codes ..... 24

# Part I: Introduction

The **LDS0400-T** (**L**aser **D**iffraction **S**ensor for **T**ransparent products) is specially built for transparent products, such as optical fiber (glass or coated fiber). It measures the diameter in production towers. Its measurement principle is based on the laser diffraction.

This method is fibre position and vibration independent.

The LDS0400-T instrument uses the latest technology to give the maximum performance.

**Main Advantages**

- Accurate diameter measurement.
- Fiber vibrations measurement independent.
- Real time tolerances checking.
- Fiber position and vibration measurement.
- Spool length and speed computing.
- Compact and hardened industrial instrument.
- Local display of measures and parameters.

CERSA-MCI develops and produces also complementary high performance measurement instruments for optical fiber production, at high drawing speed like:

- **LIS-G** for Glass fiber diameter, spinning, non-circularity measurement and defect detection (including airline).
- **NCTM** for Glass fiber drawing tension measurement.
- **CM-5** for Coated fiber diameter, Lump & Neck detection,internal defect detection and asymmetry measurement.

# Part II: Specifications

## 1 General specifications

***Important:*** *Instrument must absolutely be placed before any pulley or cabstan*

**ABSOLUTE DIAMETER MEASUREMENT**

| | |
|---|---|
| Range : | **50-400 µm** |
| Uncertainty : | ±0.15% of the diameter (limited to ±0,15µm) without averaging<br>±0.10% (averaged on BNC output)<br>*Remarks:*<br>Includes slow ambient temperature fluctuation within 10-35 °c.<br>Includes fiber moves within 1.5mm radius circle |
| Repeatability : | **±0,07% of the diameter** (limited to ±0,10µm) |
| Measurement frequency : | **400 Hz** |

**X & Y POSITION MEASUREMENT**

| | |
|---|---|
| Range : | ±2mm |
| Uncertainty : | ±0,1mm |
| Measurement frequency : | 1KHz |

**VIBRATION FREQUENCY MEASUREMENT**

Using position measurement, the instrument computes by F.F.T.(Fast Fourier Transform) the vibration frequency which can be transferred to CIM software.

**BNC OUTPUTS**

| | |
|---|---|
| Quantity : | 4 |
| Voltage range : | ±10V |

**DIGITAL OUTPUTS (Open collectors)**

For alarms, fiber defect, tolerances...

| | |
|---|---|
| Quantity : | 8 |

**DIGITAL INPUTS**

For length counting and length reset.

| | |
|---|---|
| Quantity : | 2 |

**RS232 COMMUNICATION**

Used to connect the instrument to CIM software

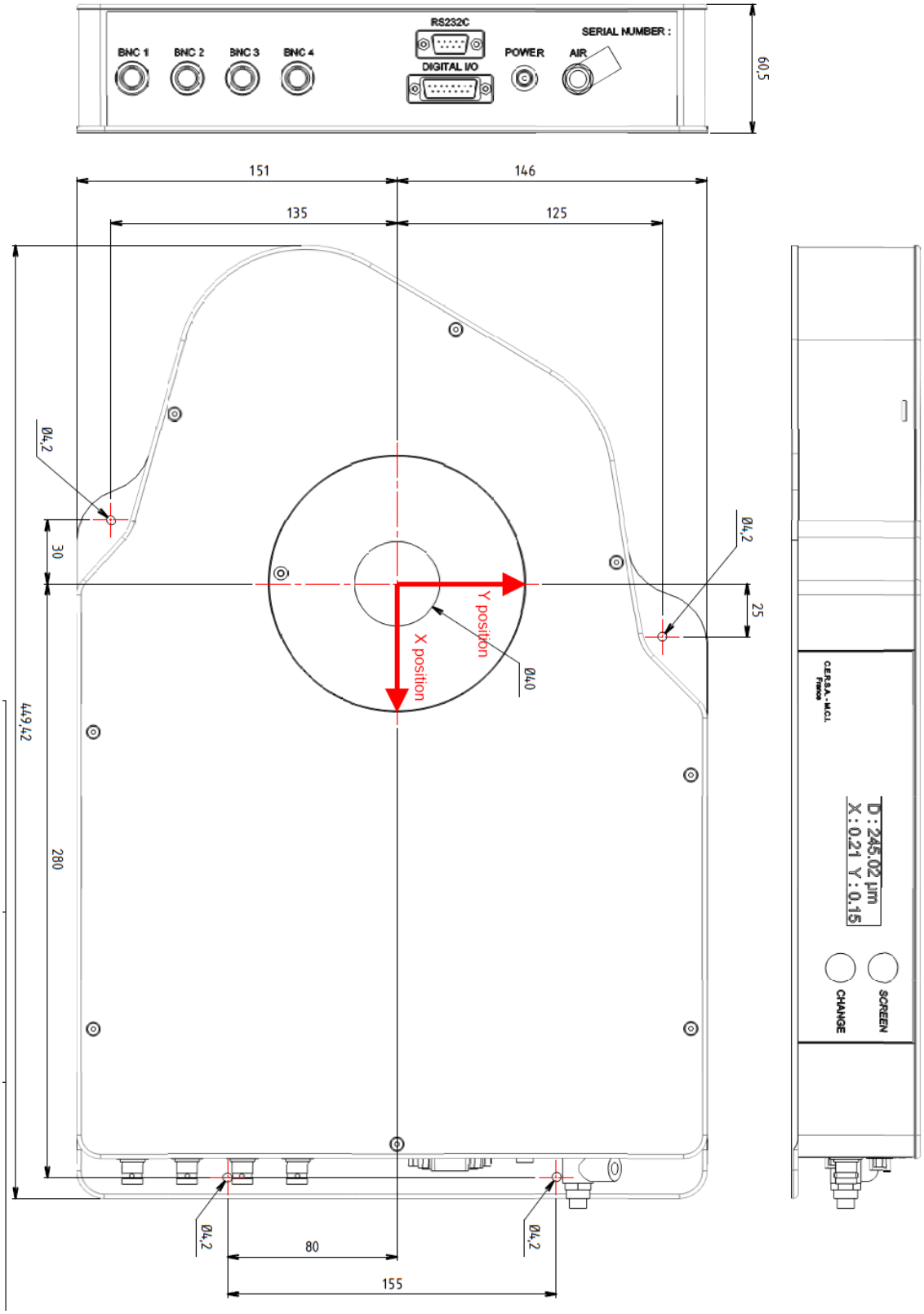
| | |
|---|---|
| Baudrate : | 115200 |
| Maximum cable length : | 35 meters (certified only with cables supplied by CERSA) |

**ENVIRONMENTAL CONDITIONS:**

Air flow of 5 to 20 litters per minute required to clean the optics and cool down the electronic.

| | |
|---|---|
| Ambient working temperature : | 10 - 35 °c |
| Maximal working internal temperature : | 55 °c |
| Storage temperature : | 0 - 60 °c |

# 2 Mechanical design

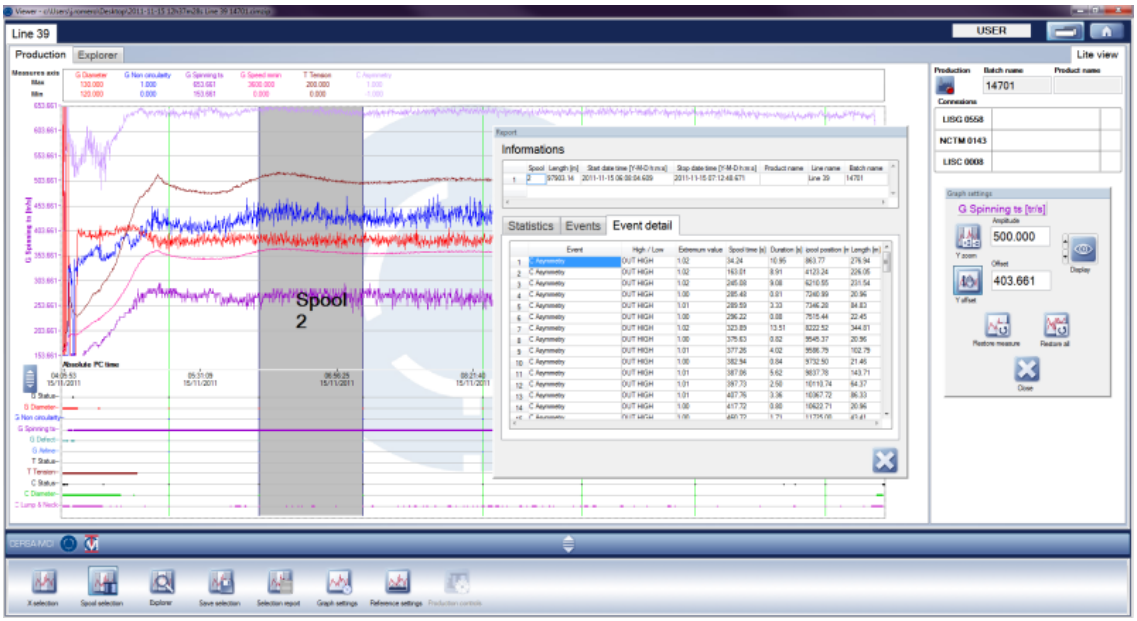



- Weight: 4,7 kg

- Weight of the external supply: 300g.

# Part III: CIM software

C.I.M. software (CERSA Instruments Manager) is a new PC environment that manage all CERSA-MCI instruments. It provides a complete set of comprehensive tools to improve and master the production process as well as all features to certify the whole production specifications in line.




**Main features :**

- Monitoring the process in real time.
- Data logging (database).
- Production reports.
- Instruments configuration.

**Acces level :**

2 access level are defined: **user** and **supervisor**.

- The supervisor level has no restriction.
- The user level is limited to the basic operator use, some advanced configuration are disable.

# Part IV: Measures and principle

## 1 Generalities

### 1.1 Available measures

Here below is the list of measures transferred from the instrument to CIM.

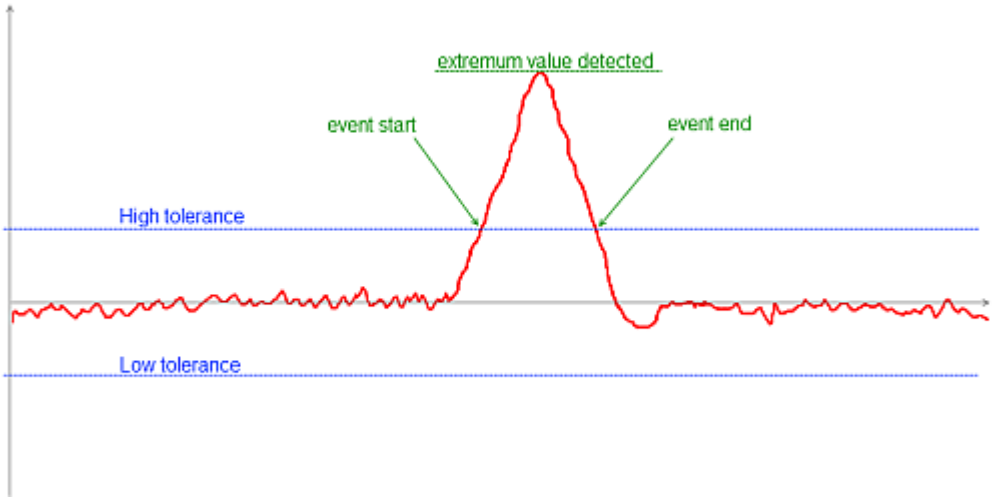
| Measure | unit | Description | access level |
|---|---|---|---|
| Diameter | [µm] | Value of the outer diameter. | user |
| Speed mmin | [m/min] | Value of the production speed. | user |
| Speed ms | [m/s] | Value of the production speed. | user |
| Temp. | [°C] | Value of internal temperature of the instrument. Should not exceed 55°. | supervisor |
| Vibration | [Hz] | Value of the vibration frequency of the measured object. | user |
| X position | [mm] | Value of the X position for the measured object. | user |
| Y position | [mm] | Value of the Y position for the measured object. | user |

**Remark:** A non-measured value is forced to zero, except for X & Y positions which are force to -5.00mm

### 1.2 Events

It is a particular phenomenon that is detected by the instrument. Events are detected in real time, dated (3ms accuracy) and located (fiber length). Each event is also characterized by its extremum value.

Here below is an example of high speed diameter fluctuation which exceeds the tolerances.




Here below is the list of events transferred from the instrument to CIM:

| Event | unit | Description | access level |
|---|---|---|---|
| Diameter | [µm] | Diameter event is generated in case of out of tolerances. | user |
| Status | | General status of the instrument. | user |

## 1.3 Real time scopes

Because the measurement frequency of the instrument is very high, it is impossible to transfer all measures in real time to the computer through RS232.
The instrument stores the main measures continuously in internal buffers of 500 points each . This function is called Real Time Scope.

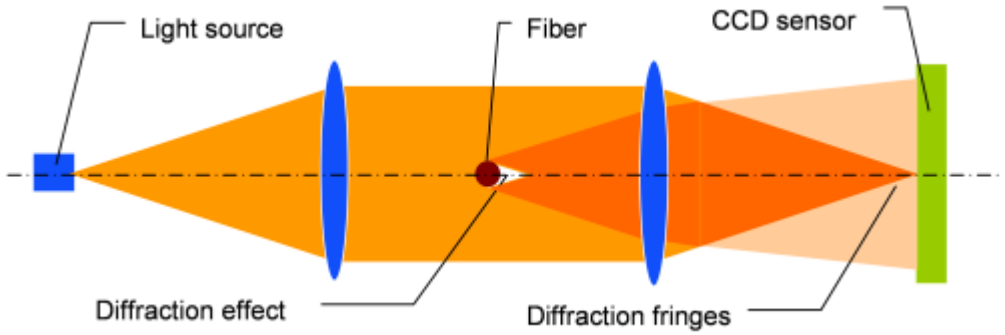
Those buffers can be watched through CIM. Only few buffers per seconds can be watched, because of communication constraints.

The sampling period of each buffer can be modified, depending on the time scale you want to analyse.

Those tools are very useful for process analysis to qualify the stability, the regulation performance, and display some particular effects. The F.F.T. processing shows specific oscillations. We recommend strongly to the process engineer to use those tools for understanding and improvement of the manufacturing process.

# 2 Diameter

## 2.1 Optical principle

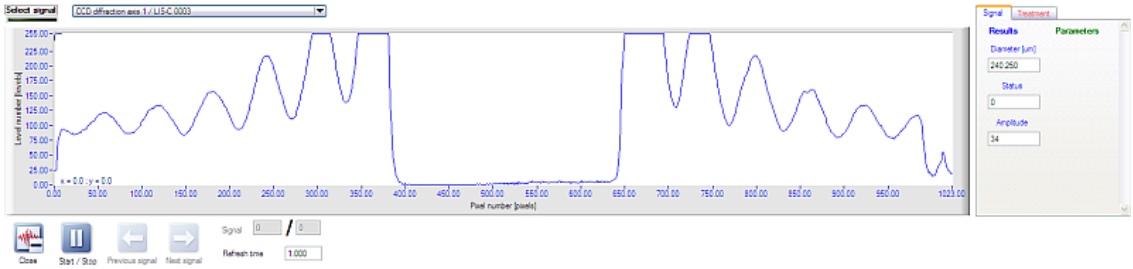



The light ray deviation due to a material tangential effect creates a diffraction phenomenon. When a fiber is placed in a collimated light source, two symmetrical effects appear on each side of any fiber diameter, like two new sources of coherent light, producing interferometric fringes perpendicular to the fiber. **The period of the fringes is a direct function of the fiber diameter** .
An optical system concentrates the fringe signal on a linear CCD sensor. Due both to the phenomenon and to the optical system, the sensor signal is fiber position independent.
The fringe signal comes from the angular deviation of the rays. All the parallel rays from the laser source are focused on the center of the CCD where the optical mask is placed. All the rays deviated by the fiber, reflection and diffraction, in the same angular direction are focused at the same position on the CCD sensor. Thus when the fiber moves or vibrates, the fringe signal does not change.

## 2.2 Diffraction scope

This scope shows 1 signal:

- ***CCD diffraction axis 1:*** Light energy vs pixel. It shows the signal acquired by the CCD.



This scope is used for maintenance purpose to check the signal quality.

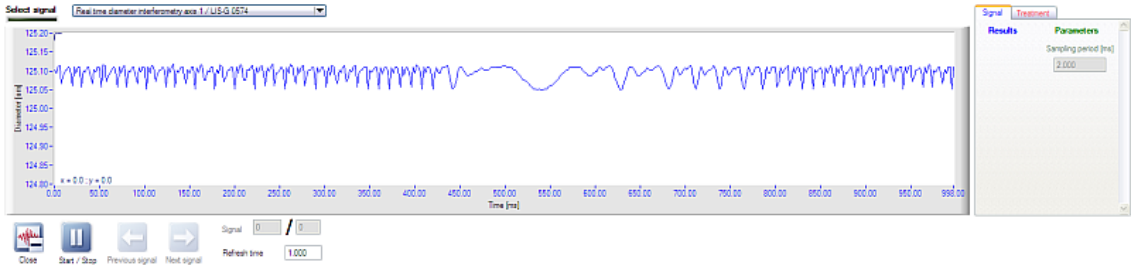
**Results** displayed in the scope**:**

- **Diameter**: the diameter measure corresponding to the displayed signal.
- **Status**: the alarm code corresponding to the displayed signal.
- **Amplitude**: the fringes amplitude. This value should be around 30-40 for 245µm fiber, otherwise the instrument is not good conditions for measurement.

## 2.3 Real time diameter scope

This scope shows 1 signal:

- ***Real time diameter diffraction:*** Diameter vs time. It shows real time diameter fluctuations.



This scope is interesting for process study and analysis. It can show high speed phenomenon, such as spinning or diameter oscillations.

The following **parameter** can be adjusted:

- **Sampling period [ms]**: Represents the duration between 2 storages inside the buffer. It is used to adapt the time scale. Minimum value: 2.500ms.

# 3 Position and vibration

## 3.1 Principle

Fiber position is measured by 2 position sensors: X and Y.
Those 2 PSD (Position sensitive detectors) analyse the light diffused by the fiber and provide an accuracy of +/-0.1mm.
The measurement range is limited to +/-2.0mm on both sensors.

The vibration frequency measurement comes from the spectrum analysis of the Y position signal (more sensitive than X). It can be measured only if oscillations are stable and large enough.

# 3.2 Vibration scope

This scope shows 2 signals:

- ***F.F.T. of the Y position:*** Energy vs frequency. It shows the normalized Fast Fourier Transform of the Y position signal..
- ***Y postion signal:*** Y axis position vs time. It shows fiber position measured by the Y position sensor.

This scope is interesting for vibration analysis. When the instrument is placed between the furnace and the first coating die, it can display the natural fiber vibration which is an image of the drawing tension.

**Results** displayed in the scope**:**

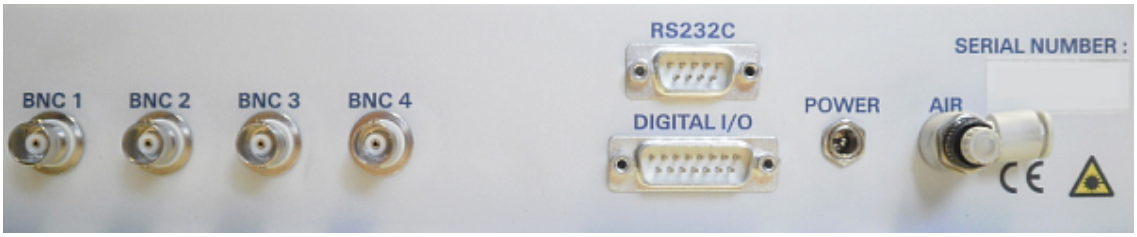
- **F.F.T. DC energy**: represents the F.F.T. level of the DC part (Frequency = 0Hz)
- **F.F.T. peak energy**: represents the F.F.T. level of the main peak.
- **Frequency [Hz]**: the vibration frequency value of the detected F.F.T. peak.

The following **parameters** can be adjusted:

- **Sampling period [ms]**: Represent the duration between 2 storages inside the buffer. It is used to adapt the time scale. Minimum value: 1.000ms.
- **Min window [Hz]:** The minimum frequency used to search for a F.F.T. peak.
- **Max window [Hz]:** The maximum frequency used to search for a F.F.T. peak.
- **Min peak energy:** The minimum energy to be considered as a peak.
- **Min peak level:** The minimum normalized peak level to be considered as a peak.
- **Max peak width[Hz]**: If a peak is detected, its width (referring to the min peak level) should not exceed the max peak width to be considered as a real peak.

# Part V: Connexions and Interfaces

Here below is the rear face of the instruments:




## 1 Digital I/O

IN/OUT connector is a SUB-D 15 pins. It is used for alarms and external controls.

- 8 Outputs (open collectors 60 VCC max, 24 or 48 standard DC voltages) with common ground.
- 2 floating opto-isolated Inputs with common anode designed for 24V DC for open collectors. Other voltages on demand (Internal resistors have to be adapted).

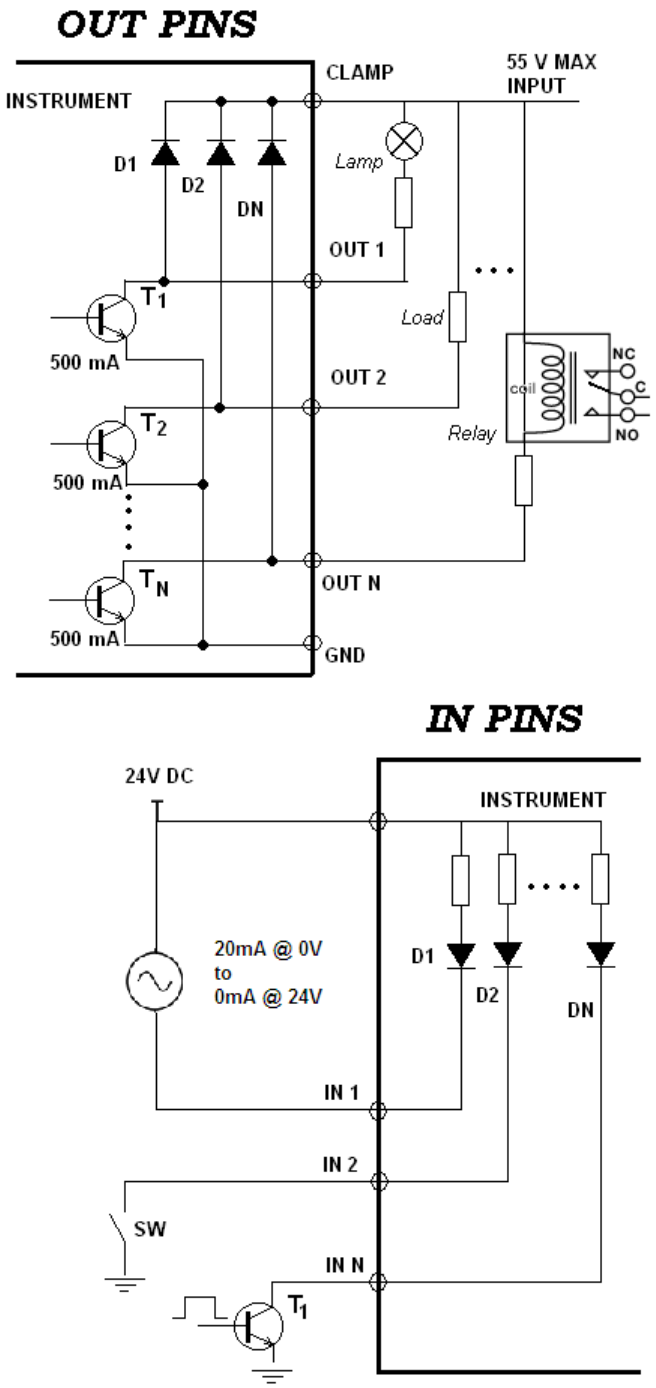
| DB15 Pin Number | | I/O type | I/O name | Description |
|---|---|---|---|---|
| | 1 | Input | SPOOL RESET | Reset fiber length. |
| 9 | | Input | LENGTH COUNTING | Fiber length counting pulses. |
| | 2 | Output | POSITION OUT | Fiber position is out of 1.5mm circle radius. Measures are not certified. BNC outputs are forced to a fixed voltage. |
| 10 | | Output | NOT USED | |
| | 3 | Reference | 24VIN | User's DC external voltage for inputs (V+) |
| 11 | | Output | LOW | Diameter < Low tolerance |
| | 4 | Output | HIGH | Diameter > High tolerance |
| 12 | | Output | NOT USED | |
| | 5 | Output | RUN | Instrument is running (power is on) |
| 13 | | Output | NOT USED | |
| | 6 | Output | NOT USED | |
| 14 | | Output | NOT USED | |
| | 7 | Reference | CLAMP | Diode protection input when one relay is monitored |
| 15 | | Reference | GND | Voltage ground reference for 24VIN and outputs |
| | 8 | Reference | GND | Voltage ground reference for 24VIN and outputs |

**Output states:**

- When the output is activated (example: Fiber position is out), the collector is open.
- When the output is not activated (example: Fiber position is correct), the collector is closed.

**Input states:**

- To activate the input (example: to reset the length), you must force the potential of the input from 24VIN to GND.
- To deactivate the input, you must release the potential of the input (internal pull-up to 24VIN) or force it to 24VIN.




**Remark:**

- Lamp, Load and Relay are shown as user application examples.

# 2 Length counting use

If you connect the length counting signal and the reset signal, the instrument will compute the speed and length with the same reference as your production system. It permits the instrument to locate accurately all events in the spool. It can help you to determine the portion of product to reject.

The length counting interface has to be configured under CIM software (*Parameters manager / Digital interface*) with the following parameters:

**Pulses number:** The number of pulses for 1 meter length.
**Slip factor**: in case of the real speed and the measured speed are not perfectly correlated, you can adjust this factor. This multiplication factor is applied to the measured speed. Default value: 1.0

*Remark: Those parameters are accessible in CIM software in Parameters manager / Digital interface tab.*

# 3 Serial link

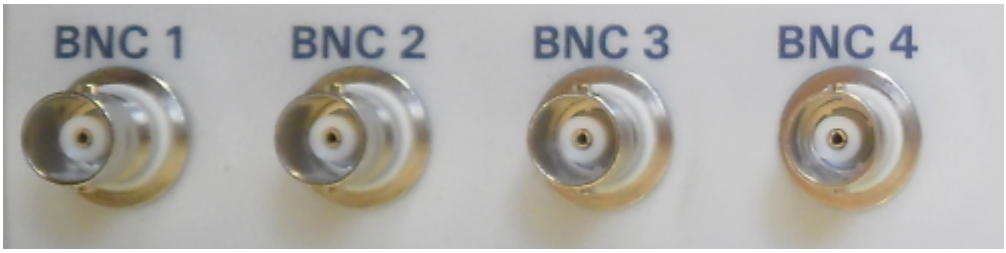
The dedicated pins of the serial link SUB-D9 pins connector of the instrument are:

| DB9 Pins nb. | | IN/OUT | Signal | connect to PC DB9 Pins nb. |
|---|---|---|---|---|
| | 1 | | | |
| 6 | | | | |
| | 2 | OUT | TXD: Data out | 2 (RxD) |
| 7 | | IN | CTS: Clear to send | 7 (RTS) |
| | 3 | IN | RXD: Data in | 3 (TxD) |
| 8 | | OUT | RTS: Ready to send | 8 (CTS) |
| | 4 | | | |
| 9 | | | | |
| | 5 | | GND: voltage ground ref | 5 (GND) |

The cable to use is a **standard straight RS232 cable** (pin to pin) . It must be shielded.
CERSA provides on demand 15, 25 or 35 meters certified cables.

**Communication settings:**
- baudrate: 115200 bauds
- data bits: 8
- parity: even
- stop bit: 1

# 4 BNC Outputs




**Specifications:**

- Voltage range: ±10V
- Accuracy: ±50mV
- Minimum resistive load: 10kΩ with short circuit protection.
- Maximum capacitive load: 100pF

Here below is the measurement type provided on each BNC.

| BNC 1 | BNC 2 | BNC 3 | BNC 4 |
|---|---|---|---|
| Accurate diameter output | X position output | Y position output | Large scale diameter output |

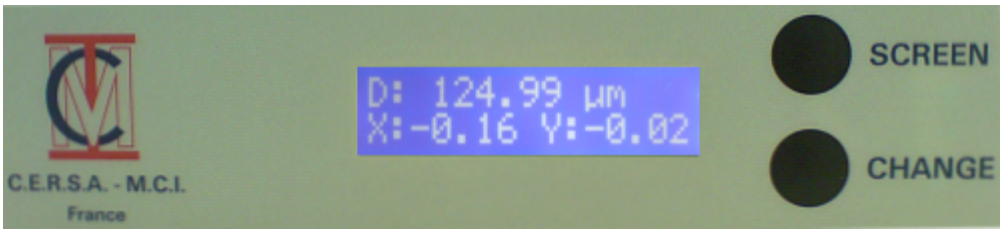
**Remarks:**

- Output voltage is limited from -10 V to +10 V.
- Output scales are adjustable with the following parameters under CIM software (*Parameters manager /Analog interface*):

**Zero point:** When the measured value reaches the zero point value, the corresponding analogical output is set to 0V. The unit of the zero point is the same as the corresponding measure.
**Scale:** Is the number of volts per measure unit. For example for position in millimeters 2 [V/mm]: if the measure varies of 1mm the value of analog output varies of 2 Volt.
**Regulation:** If this option is activated, then the zero point value is automatically forced to the nominal tolerance value of the corresponding measure. Otherwise the zero point can have any value.
**Average time:** Is the average time used to compute the analog output signal.

# 5 Front panel

A back lighted LCD displays the different parameters available locally. It is controlled by two push buttons.

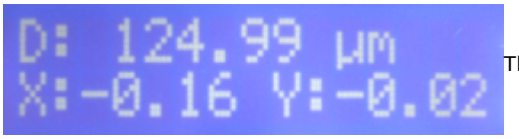



**SCREEN**: will change type of information to display.

**CHANGE**: is used to modify the settings.

At start up, the screen displays the instrument serial number and last embedded software version.

By pushing on SCREEN button, you can display the following information:




This screen displays **Diameter**, **X position** and **Y position**

This screen displays the produced **Length** and the **Speed**.

By pushing on CHANGE button, you will reset the length to zero.

This screen displays the internal **Temperature**.

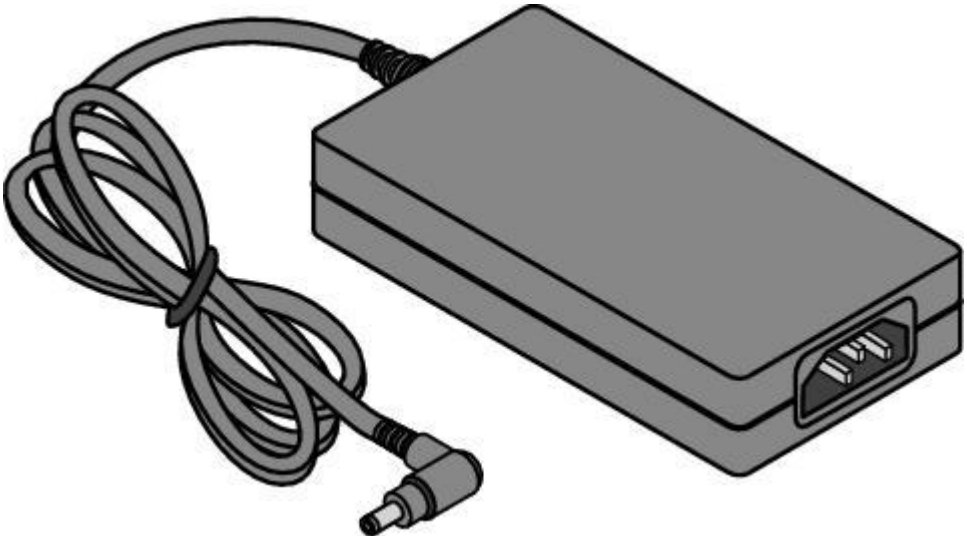
**Remark:**

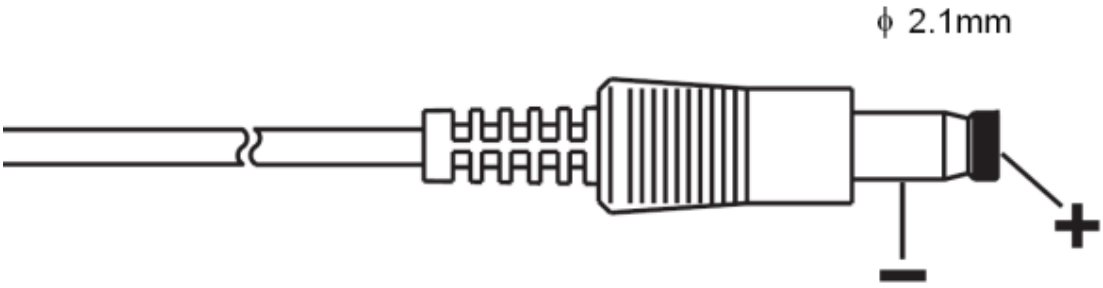
You can reset the instrument (load factory data), you must push SCREEN and CHANGE buttons together just after powering-up the instrument.

# 6 External power supply

The instrument comes with its CERSA MCI's power supply. This power supply provides +12V volts rectified and filtered DC voltage with a power of 45W as well as ground protection continuity. An short-circuit protection is included.

Input voltage : from 100V to 240V AC, 50 to 60 Hz.






# 7 Air supply

A standard connector for 6mm PVC air pipe is included on the rear panel. The air exit inside the lens mechanical protection.

A clean and dry air flow of 5 to 20 litters per minute is required to clean the optics and cool down the electronic..

The air supply is absolutely needed for cooling down. The instrument can be damaged if the air is not connected to the instrument (internal overheat).
It has also the interest to avoid dust to deposit on the lenses.

# Part VI: Instrument settings

A full set of parameters can be adjusted using CIM software.

**Remark:**
All parameters are stored and saved in a embedded EEPROM.

## 1 Tolerances

The instrument monitors in real time if the measures are in or out of the product tolerances.
In case of tolerance defect, the instrument will act as follow:

- Digital output state will change. Refer to the Digital I/O chapter.
- Data are transferred to CIM which will show **events** with full details about dating, positioning and extremum values.

Here below is the logic used for tolerance control:

| | |
|---|---|
| Measure > Nominal tolerance + Warning high tolerance | EVENT WARNING HIGH (Not yet available) |
| Measure < Nominal tolerance - Warning low tolerance | EVENT WARNING LOW (Not yet available) |
| Measure > Nominal tolerance + Out high tolerance | EVENT OUT HIGH |
| Measure < Nominal tolerance - Out low tolerance | EVENT OUT LOW |

Here below is the full list of tolerances parameters that can be adjusted with CIM software ( *Parameters manager /Tolerances*):

| Parameter | unit | Description | access level |
|---|---|---|---|
| Avg. time diameter | [ms] | Time during which the diameter will be averaged to compute out of tolerances. (enter zero to disable) | supervisor |
| Nominal diameter | [µm] | Nominal diameter value. | user |
| Out high diameter | [µm] | Maximum diameter tolerance. (enter zero to disable) | user |
| Out low diameter | [µm] | Minimum diameter tolerance. (enter zero to disable) | user |
| Warning high diameter | [µm] | Maximum diameter warning tolerance. (enter zero to disable) | user |
| Warning low diameter | [µm] | Minimum diameter warning tolerance. (enter zero to disable) | user |

## 2 Measure parameters

Here below is the full list of measures parameters that can be adjusted with CIM software( *Parameters manager /Measures*):

| Parameter | unit | Description | access level |
|---|---|---|---|
| Avg. time display diam. | [ms] | Averaging time of the diameter measure shown on the local display and transferred to CIM. | supervisor |
| Diameter offset | [µm] | Offset applied on the diameter value. It can be used to correct the calibration of the instrument. | supervisor |
| Pos. out ana. val. | [V] | In case of position out, the voltage value to apply on all BNC. | supervisor |
| Pos. out tempo | [s] | If the object to measure leaves the measurement area during this time, it is considered as position out. All | supervisor |

| | | | |
|---|---|---|---|
| | | measures are forced to init value. | |

**Remark about diffraction diameter calibration:**
Thanks to the optical system and measurement principle, you should not modify the offset value (default value: 0). In case of you really need to correct the measure, you have to follow this procedure:

1. Wait for the **temperature stabilization** for at least 1 hour.
2. Be sure of the **cleanness** of the optical system.
3. You must have a **standard** fiber or metallic wire. The standard has to be very circular (non-circularity less than 0.2µm) and must be measured by an external accurate offline measurement system.
4. Clean perfectly this standard with IPA(IsoPropylic Alcohol).
5. Place this standard (without touching the part which will be measured) in the center of the LIS. Be sure that the standard **position** is around 0.0mm (+/- 0.2mm).
6. Enter the value of your standard, it will **calibrate instantaneously** your instrument.

# Part VII: Installation on the line

## 1 Mounting

You do not need any fine adjustable support. A single horizontal metal plate, 3 mm thick, with 4x ∅4.20mm holes would be sufficient.
You must reserve the possibility of a manual adjustment to adjust the position of the instrument on the fiber axis.

In case of the instrument is used for bare fiber, pay attention to the following:

- To have the best regulation response, the instrument has to be near the furnace (2m to 5m).
- Because the glass fiber is a important heating source, the internal temperature must be checked (55 degrees maximum) with CIM software during fiber drawing, especially at the highest production speed.

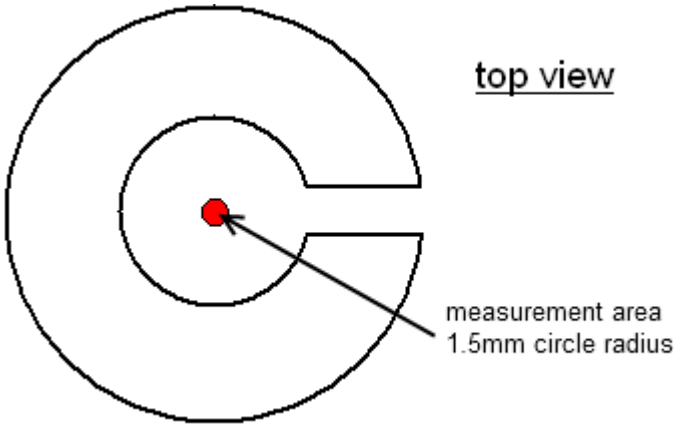
**Remark:**

- At very high production speed the fiber itself becomes an important heating source.
- Air supply is necessary to maintain the internal temperature and ensure the behavior of electronic devices. Refer to Air supply chapter.

## 2 Alignment

All measures are independent of the fibre position while the fibre stays within 1.5mm radius.

We recommend to keep the fiber within a 1.0mm circle radius.




Out of a 1.5mm circle radius, the measurement is not possible.

# Part VIII: Maintenance, security and troubleshooting

## 1 Safety rules

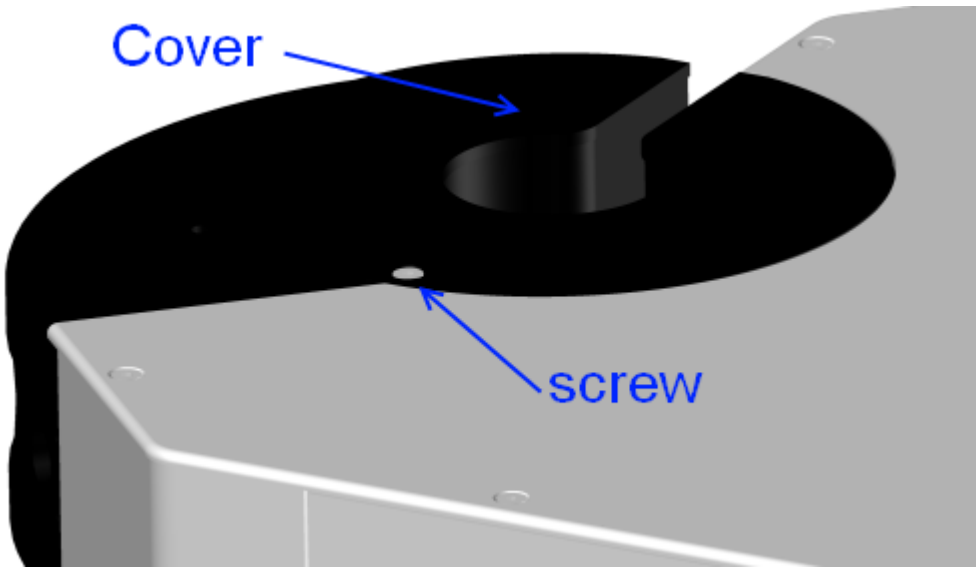
There is no particular protection constraint for users in the case of a normal operation of the devices.

**Laser source information:**
The laser is not directly visible if you keep mounted the black cover.
Class 1 laser device according to the classifications given by the "The Food Administration" of the United-States, document FDA 81-8140, section 1040-10.

## 2 Optical system cleaning

The lenses cleaning should be performed regularly depending on the environment.
In most of the cases, a simple dry air blowing action each month into the lenses protection is sufficient.
The user must remember that dust on the lenses degrades the device's accuracy.

To clean the lenses, please follow this **procedure**:
1. Unplug the power supply.
2. Remove the top black cover (you must first remove the screw).
3. Use dry air to eliminate the biggest particles.
4. Use cotton or dry tissue with IPA (IsoPropylic Alcohol) and clean carefully each dirty lens.
5. Check visually the surface of the lenses.
6. Replace the cover and tight the screw.



# 3 Error codes

In case of measurement problem or error, the instrument will show on the local display an error code.
This code is also transferred to CIM which will display a short text. For further details about these codes, please refer to the following table:

| Error code value | Text displayed in CIM | Description |
|---|---|---|
| 11 | WARNING HIGH | Tolerance current state warning high |
| 8 | WARNING LOW | Tolerance current state warning low |
| 5 | OUT HIGH | Tolerance current state out high |
| 2 | OUT LOW | Tolerance current state out low |
| 0 | OK | Status is OK |
| -1 | RESET SPOOL | Indicates a spool length reset event |
| -2 | EVENT MAX | CERSA Internal event |
| -3 | ANA END SET | CERSA Internal event |
| -4 | ANA START SET | CERSA Internal event |
| -5 | ANA OUT | CERSA Internal event |
| -6 | DRIFT | CERSA Internal event |
| -7 | SPINNING INIT | CERSA Internal event |
| -8 | INT. EMPTY | CERSA Internal event |
| -9 | INT. LOST | CERSA Internal event |
| -10 | DIFF. ERR. | Diffraction measurement error |
| -11 | SPINNING ADAPT | CERSA Internal event |
| -12 | ASYM NUM ERR. | Asymmetry measurement error |
| -13 | DIAM NUM ERR. | Diameter measurement error |
| -14 | RS232 ERR. | RS232 communication error |
| -100 | LOCKED | Measure is locked. |
| -200 | HIGH TEMP | Temperature is too high |
| -201 | SOURCE | Source regulation problem |
| -202 | UNST TEMP | Temperature is not stable |
| -203 | CCD | CCD sensor error |
| -204 | EEPROM | CERSA Internal event |
| -205 | MCBSP C32 | CERSA Internal event |
| -206 | MCBSP FO | CERSA Internal event |
| -207 | ECAN FO | CERSA Internal event |
| -208 | CCD READ INT | CERSA Internal event |
| -209 | HW VER. INC. | CERSA Internal event |
| -300 | POSITION OUT | Fiber position is out of the measurement area |
| -301 | WRONG POSITION | Fiber position is not correct |
| -400 | SIGNAL LOW | Signal is not correct for analyse |
| -401 | SIGNAL SATURATE | Signal is not correct for analyse |
| -402 | SIGNAL DIRTY | Signal is not correct for analyse |
| -403 | SIGNAL OUTRANGE | Signal is not correct for analyse |
| -499 | SIGNAL | Signal is not correct for analyse |
| -501 | ALGO ASYMETRY | Signal is not correct for analyse |
| -502 | ALGO MINMAX | Signal is not correct for analyse |
| -503 | ALGO PERIOD | Signal is not correct for analyse |
| -504 | ALGO ZERO | Signal is not correct for analyse |
| -505 | ALGO CALCUL | Signal is not correct for analyse |
| -506 | ALGO NBFRINGES | Signal is not correct for analyse |
| -507 | ALGO NOFRINGE | Signal is not correct for analyse |

| Error code value | Text displayed in CIM | Description |
|---|---|---|
| -508 | ALGO ZEROSIDE | Signal is not correct for analyse |
| -509 | ALGO ASYNC | Signal is not correct for analyse |
| -599 | ALGO | Signal is not correct for analyse |